Tennessee Science Curriculum Framework

Scientific Research

Course Description

Scientific Research is a laboratory science course that enables the student to both apply and expand previous content knowledge toward the endeavor of engaging in an open-ended, student-centered investigation in the pursuit of an answer to a question or problem of interest.

Scientific Research students will study:

- Technology and Engineering
- Practice Ethics
- Think Critically
- Investigate (note: substitutes for the 9-12 Embedded Inquiry Strand)
- Analyze and Evaluate Data
- Communicate Results

Embedded Technology and Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Course Level Expectations

CLE 3295.T/E.1 Explore the impact of technology on social, political, and economic systems.

CLE 3295.T/E.2 Differentiate among elements of the engineering design cycle: design constraints, model building, testing, evaluating, modifying, and retesting.

CLE 3295.T/E.3 Explain the relationship between the properties of a material and the use of the material in the application of a technology.

CLE 3295.T/E.4 Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.

Checks for Understanding (Formative/Summative Assessment)

✓**3295.T/E.1** Distinguish among tools and procedures best suited to conduct a specified scientific inquiry.

✓**3295.T/E.2** Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.
✓**3295.T/E.3** Evaluate a protocol to determine the degree to which an engineering design process was successfully applied.
✓**3295.T/E.4** Explore how the unintended consequences of new technologies can impact human and non-human communities.
✓**3295.T/E.5** Evaluate the overall benefit to cost ratio of a new technology.
✓**3295.T/E.6** Present research on current technologies that advance health and contribute to improvements in our daily lives.
✓**3295.T/E.7** Design a series of multi-view drawings that can be used by other students to construct an adaptive design and test its effectiveness.

Standard 1 – Practice Ethics

Conceptual Strand 1

Ethical practices must be adhered to during scientific research.

Guiding Question 1

What are the ethical practices that must be addressed when conducting scientific research?

Course Level Expectations

CLE 3295.1.1 Critically examine data to determine its significance.
CLE 3295.1.2 Repeat trials to enhance the reliability of data.
CLE 3295.1.3 Recognize that in science one solution often leads to new questions.
CLE 3295.1.4 Employ ethical practices with research and investigations that involve human or animal subjects and hazardous materials.
CLE 3295.1.5 Follow safety procedures in the classroom, laboratory, and home environments.
CLE 3295.1.6 Respect and understand copyright and patent laws.

Checks for Understanding (Formative/Summative Assessment)

✓ **3295.1.1** Choose appropriate sources of information.
✓ **3295.1.2** Use printed references and correct citations, referencing all sources of information.
✓ **3295.1.3** Conduct a laboratory experiment to demonstrate knowledge of proper safety procedures.
✓ **3295.1.4** Honor all copyright laws.
✓ **3295.1.5** Survey the web for sources of information concerning a scientific problem and differentiate between the sources as reliable or invalid.
✓ **3295.1.6** Complete a research plan that adheres to appropriate regulatory guidelines.
✓ **3295.1.7** Compose a review of literature using a proper format (i.e., MLA).
✓ **3295.1.8** Formulate a research plan that addresses the problem to be solved.

✓ **3295.1.9** Create entries in a journal showing date, accurate observations, collection of data, and other pertinent information.

Standard 2 –Think Critically

Conceptual Strand 2

Critical thinking skills are essential for identifying and solving scientific problems.

Guiding Question 2

What critical thinking skills are needed to investigate scientific questions?

Course Level Expectations

CLE 3295.2.1 Analyze and study classic scientific problems.
CLE 3295.2.2 Use scientific instruments to extend the human senses in observation.
CLE 3295.2.3 Recognize the limits to scientific investigations.
CLE 3295.2.4 Use technological tools and mathematical models to analyze problems or questions.
CLE 3295.2.5 Evaluate safety implications and risks associated with a question.

Checks for Understanding (Formative/Summative Assessment)

✓**3295.2.1** Compare the results of an experiment with what is already known about the topic under investigation.
✓**3295.2.2** Employ a search engine on the Internet.
✓**3295.2.3** Develop and refine a problem statement.
✓**3295.2.4** Compose a research plan.
✓**3295.2.5** Develop an awareness of the limitations to scientific investigations.
✓**3295.2.6** Compare risks and benefits to solving a problem.
✓**3295.2.7** Show correct use of scientific instruments.
✓**3295.2.8** Examine safety precautions during experimental design.
✓**3295.2.9** Recognize the value of collaboration and division of labor within a team.
✓**3295.2.10** Analyze questions using technology and mathematical models.
✓**3295.2.11** Use mathematical and computational models to analyze questions concerning the scientific research problem.
✓**3295.2.12** Write narrative descriptions of observed scientific phenomena.

Standard 3 – Investigate

Conceptual Strand 3

Investigative strategies are essential to answer a scientific question or solve a scientific problem.

Guiding Question 3

What strategies should be employed to solve a scientific problem or answer a scientific question?

Course Level Expectations

CLE 3295.3.1 Formulate a working hypothesis to guide research.
CLE 3295.3.2 Develop experimental procedures to test a hypothesis.
CLE 3295.3.3 Practice appropriate safety procedures.
CLE 3295.3.4 Collect data using a variety of scientific tools.
CLE 3295.3.5 Verify data for accuracy.

Checks for Understanding (Formative/Summative Assessment)

- ✓ **3295.3.1** Develop a testable question for a scientific investigation.
- ✓ **3295.3.2** Differentiate between variables and controls in an experiment and select appropriate variables for an experiment.
- ✓ **3295.3.3** Develop an experimental design with proper application of controls and variables for testing a hypothesis.
- ✓ **3295.3.4** Perform an experiment to test a prediction.
- ✓ **3295.3.5** Design and use appropriate procedures for laboratory and fieldwork.
- ✓ **3295.3.6** Exhibit proper safety techniques.
- ✓ **3295.3.7** Demonstrate appropriate use of scientific tools and instruments.
- ✓ **3295.3.8** Demonstrate appropriate measurement techniques.
- ✓ **3295.3.9** Maintain a well-documented project journal.
- ✓ **3295.3.10** Modify or design an alternative experimental procedure to test a hypothesis.
- ✓ **3295.3.11** Apply established procedures to novel situations.

Standard 4 – Analyze and Evaluate Data

Conceptual Strand 4

Synthesizing, analyzing, and evaluating data is a vital part of solving scientific problems.

Guiding Question 4

What problem solving skills are necessary to synthesize, analyze, and evaluate data in order to draw accurate conclusions?

Course Level Expectations

CLE 3295.4.1 Use statistical analysis to accurately analyze and interpret data.
CLE 3295.4.2 Evaluate data based in terms of accuracy and precision.
CLE 3295.4.3 Make conclusions based on data analysis and evaluations.

Checks for Understanding (Formative/Summative Assessment)

- ✓ **3295.4.1** Collect data with hand-held technology.
- ✓ **3295.4.2** Use graphing calculators or computers to process data.
- ✓ **3295.4.3** Use spreadsheets, graphing, and database programs to transform data into a table, graph, or diagram.

✓**3295.4.4** Distinguish between accuracy and precision.
✓ **3295.4.5** Analyze alternate methods for representing data graphically and interpret the results of an experiment.
✓ **3295.4.6 S**tate a conclusion in terms of the relationship between two or more variables.
✓ **3295.4.7** Examine trends in data in order to answer questions.
✓ Analyze experimental results and identify the nature and sources of experimental error.
✓ **3295.4.8** Use knowledge and data-interpretation skills to support a conclusion.
✓ **3295.4.9** Suggest alternative explanations for the same observations.
✓ **3295.4.10** Explain whether the data supports or contradicts the original hypothesis.
✓ **3295.4.11** Develop alternative hypotheses.
✓ **3295.4.12** Formulate and revise scientific explanations and models using logic and evidence.
✓ **3295.4.13** Develop a logical argument about cause-and-effect relationships in an experiment.

Standard 5 – Communicate Results

Conceptual Strand 5

Results of scientific investigations should be shared in oral and written form to a variety of audiences.

Guiding Question 5

How and with whom should the methods and results of scientific investigations be shared?

Course Level Expectations

CLE 3295.5.1 Present a scientific report in a clear, accurate, and appropriate manner to a variety of audiences.
CLE 3295.5.2 Communicate findings in order to extend the research base.

Checks for Understanding (Formative/Summative Assessment)

✓**3295.5.1** Demonstrate basic keyboarding skills.
✓**3295.5.2** Apply proper grammatical conventions to written communication.
✓**3295.5.3** Write an expository essay.
✓**3295.5.4** Organize written communication with clarity and cohesiveness.
✓**3295.5.5** Compose and present a well-enunciated oral report.
✓**3295.5.6** Present information effectively using audiovisual aids.
✓**3295.5.7** Design and implement an appropriate presentation format based upon the audience and nature of the research.
✓**3295.5.8** Prepare a technical paper.
✓**3295.5.9** Present research findings to an appropriate audience.